



Death on the Nile – Volcanoes on Trial

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The Plaintiff

Volcanic Eruptions & Egyptian Unrest

Through frequently injecting sulfate aerosols into the atmosphere volcanic eruptions are accused of:

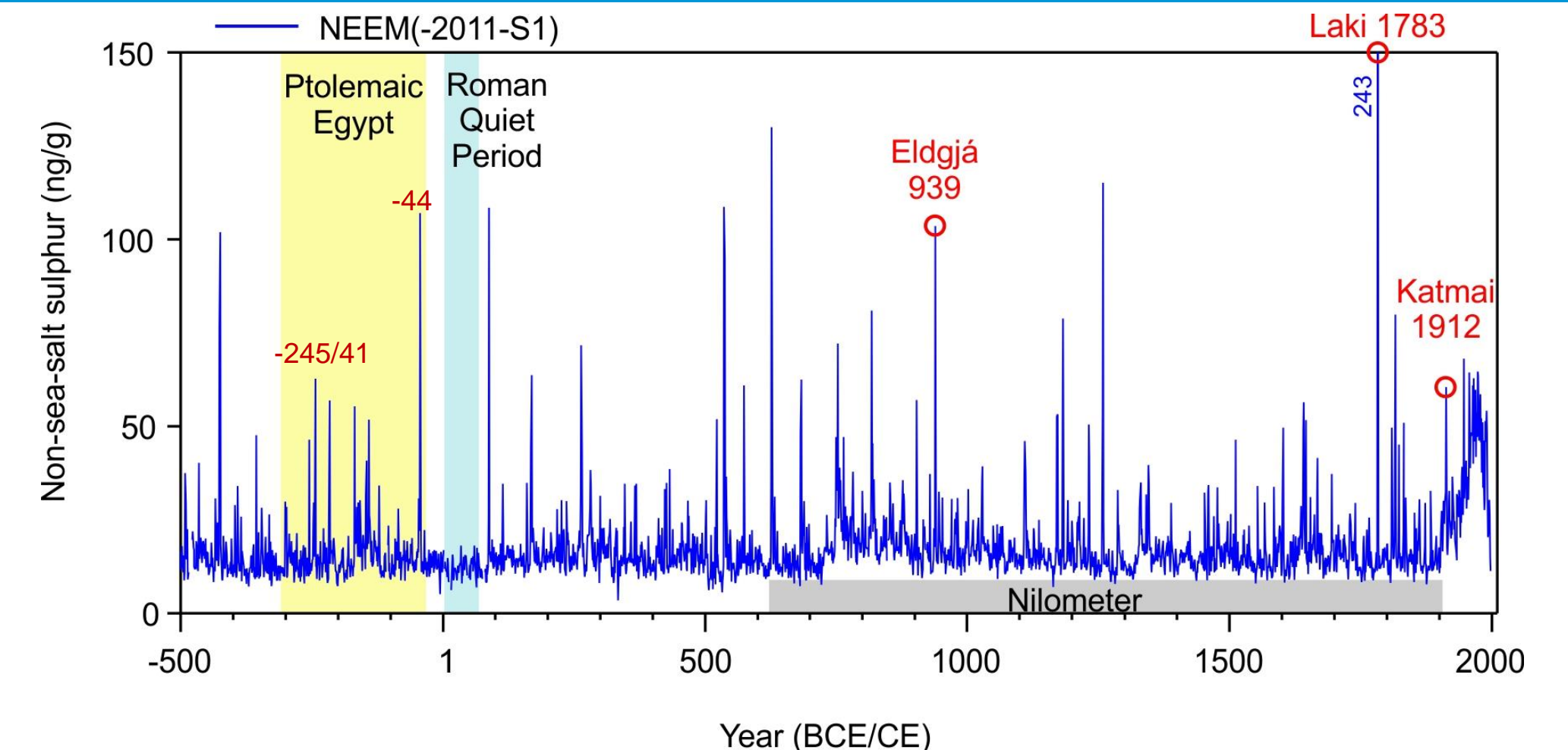
- reducing the annual **summer flood** height of the Nile River,
- promoting **crop failures** and **famines** in Ancient Egypt, coinciding with
- triggering **revolts** against elite rules,
- causing increased **socioeconomic stress**,
- constraining warfare with rivalling empires.



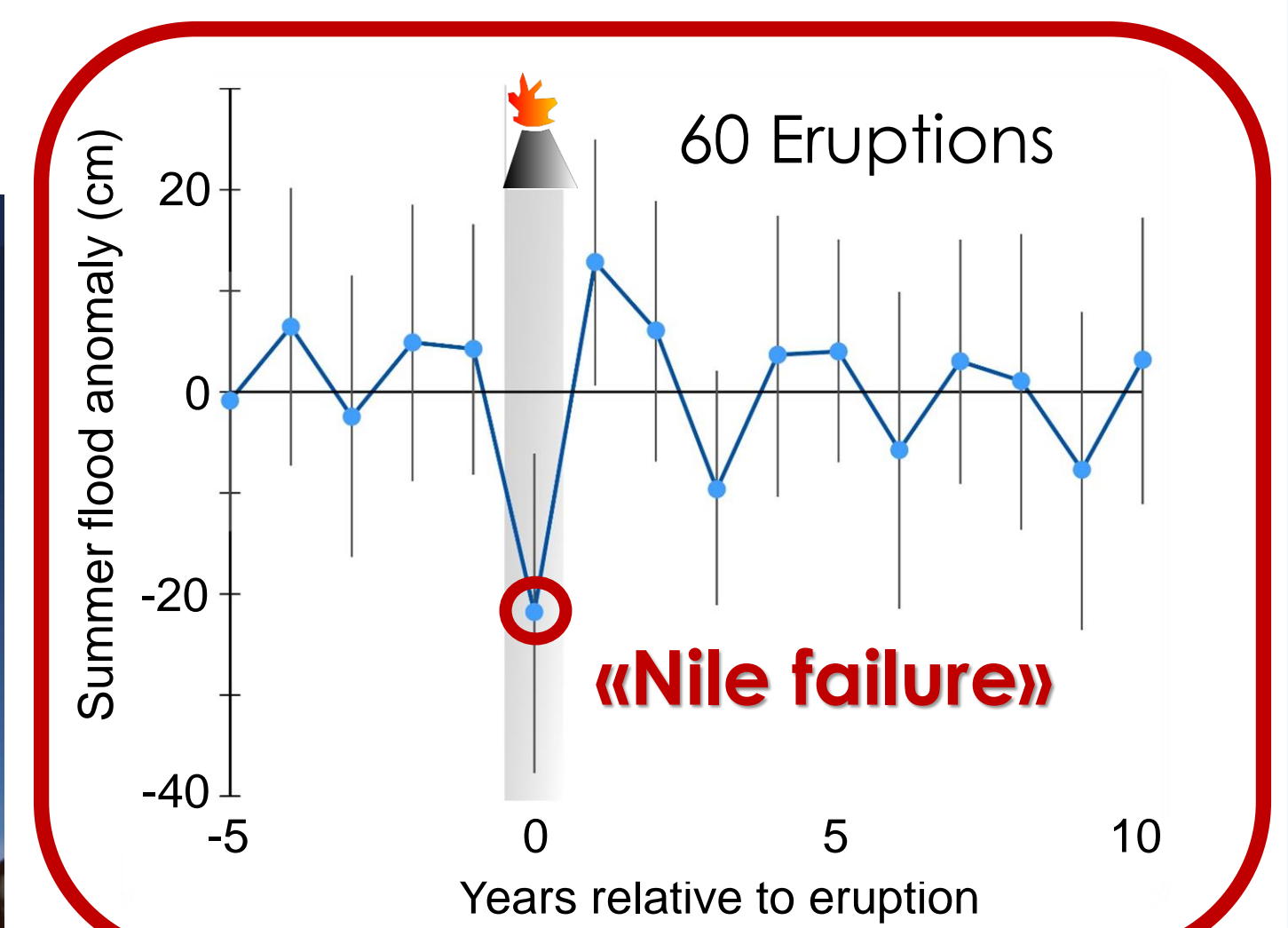
Witnesses for the Prosecution

Ice Cores, the “Nilometer” and Papyri

- Polar ice sheets “witnessed” past volcanic eruptions with almost calendar-age precision³.
- Annual “Nilometer” measurements (622-1902 CE) give evidence to the Nile flood variations⁴.
- Ancient papyri give testimony to political and societal developments during the Ptolemaic Era⁵.



Societal Consequences ← **Climate Response** ← **External Forcing**

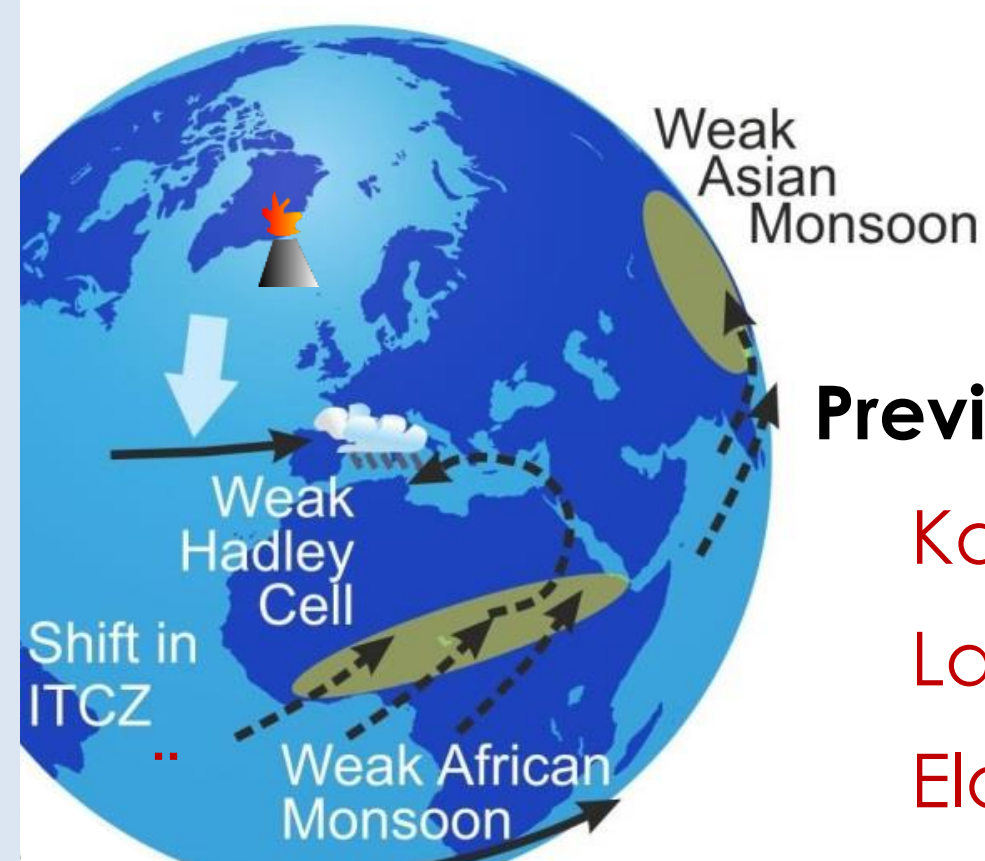


The Accused

Asymmetric Aerosol Forcing & Monsoon



Asymmetric atmospheric aerosol burden cools the Northern hemisphere (NH) preferentially, resulting in southward displacement of the Intertropical convergence zone (ITCZ) disrupting African/Asian summer monsoon.



Previously convicted^{1,2}

Katmai, Alaska, 1912 AD
Laki, Iceland, 1783 AD
Eldgjá, Iceland, 939-40 AD

The Verdict

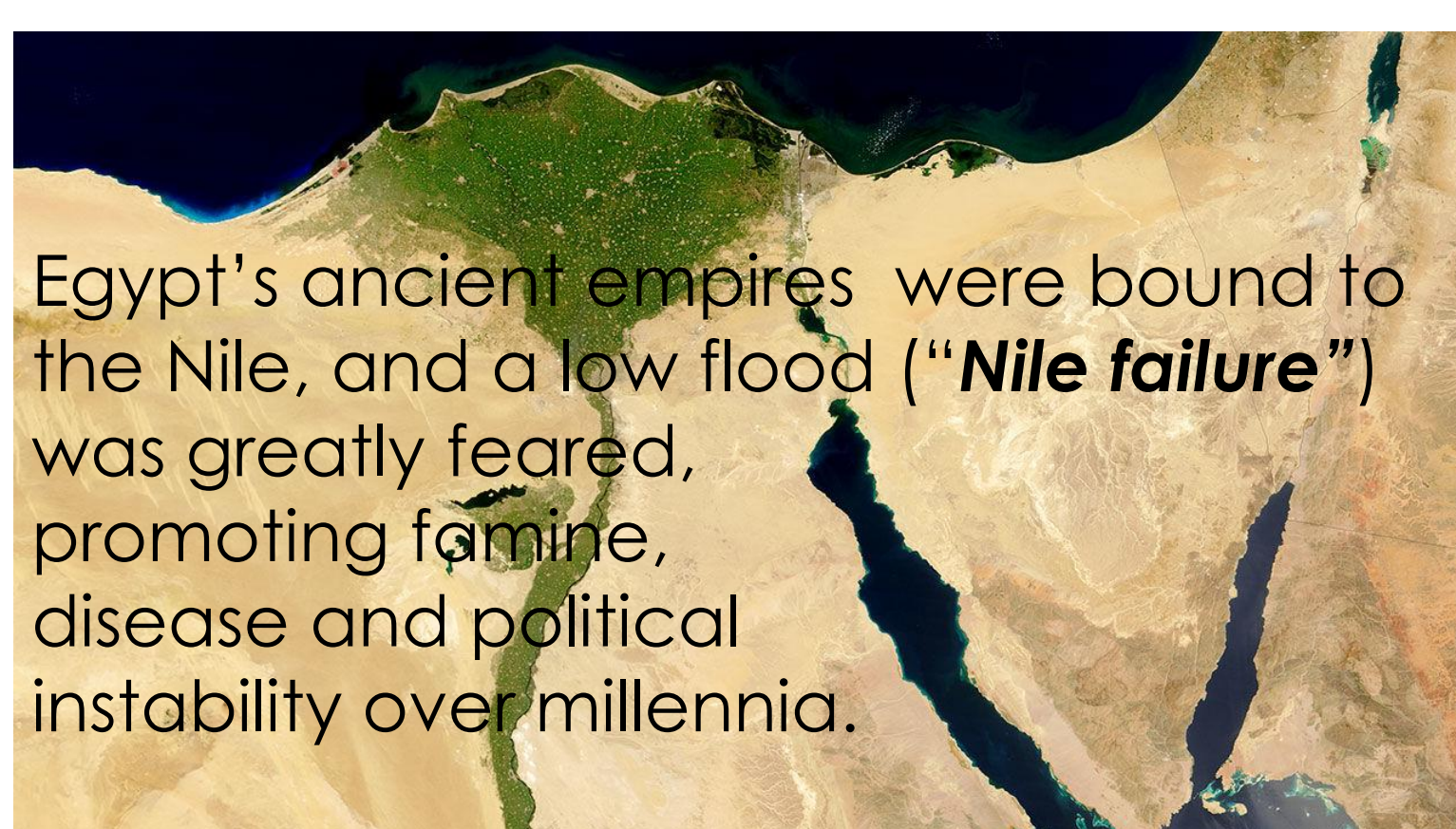
- Using unique observational records we showed a significant **reduction of the agriculturally critical Nile summer flood** in the years of volcanic eruptions via radiative and dynamical impacts on the African monsoon.
- We identified **volcanic eruptions** as a **major influence on Ancient Egyptian political and societal history**, influencing the timing of violent revolts and interstate warfare, as well as religious, economic and technical developments.
- Eruptions didn't cause these upheavals on their own (“determinism”) but they **added fuel** to existing economic, political and ethnic tensions.

Volcanoes convicted! Guilty as charged!

Ptolemaic vulnerability to remote volcanic eruptions is a salient lesson for all monsoon-dependent agricultural regions, presently home to 70% of the world's population, and a warning to “geoengineering” Earth's future climate by mimicking volcanic eruptions (“solar radiation management”)!

Find the full sentence at: www.nature.com/articles/s41467-017-00957-y and: <http://www.pages-igbp.org/ini/wg/vics/intro>

The Victim

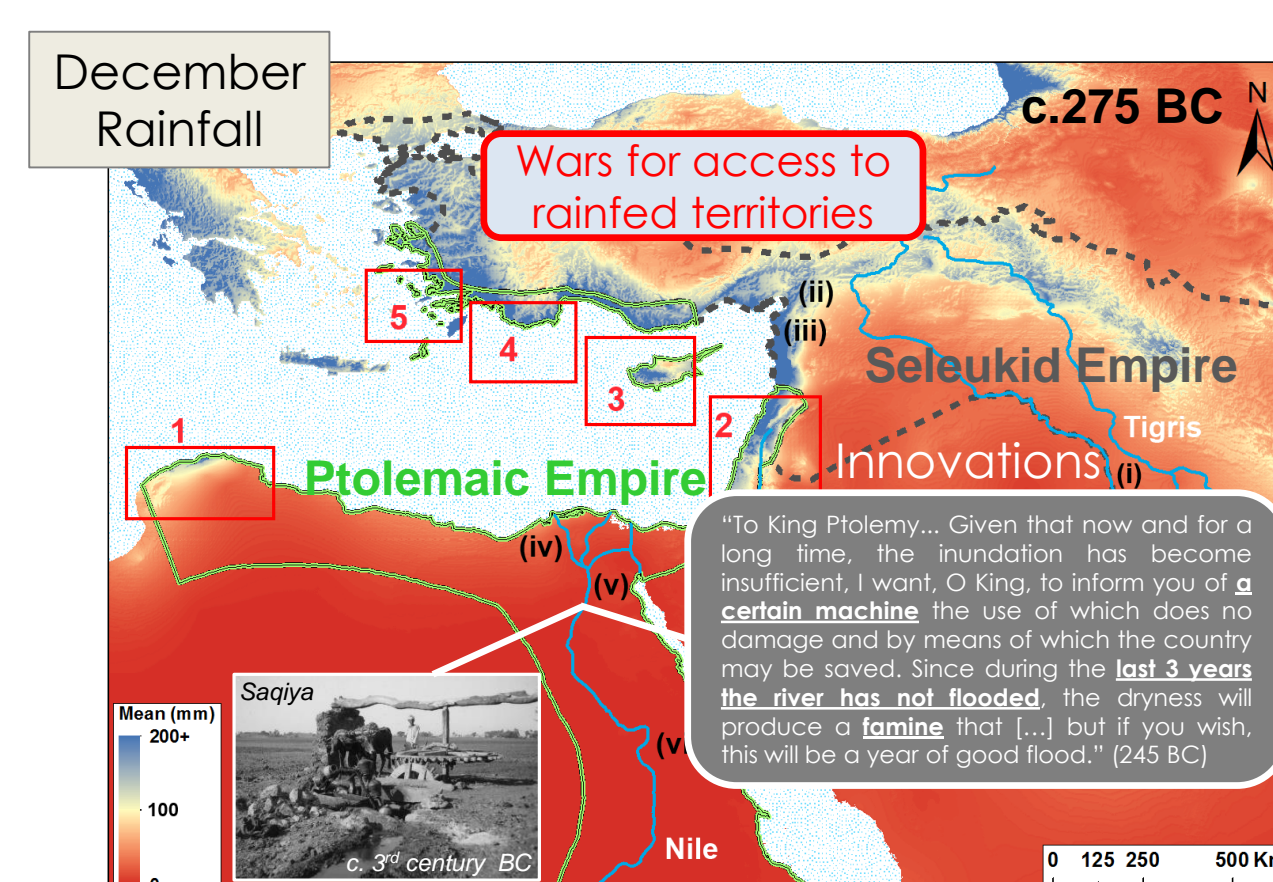


The Nile River was the lifeblood of the Ptolemaic Kingdom (305-30 BC) that ended with the death of Cleopatra.

Egyptian farmers depended critically on the yearly flooding of the Nile in July through September to irrigate their grain fields - inventing systems of channels and dams to store the river's overflow.

Resilience & Vulnerability

- Modern historians laid blame for state's decline on **politics only**! Climate has never been considered.
- **Interactions** between volcanism, annual Nile flood and Egyptian society not explainable by chance alone.
- Resilience against Nile-flood variability through **geopolitics** and **innovations**. Environmental pressures don't act in a vacuum!



Hearing of Evidence

